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ABSTRACT

A doctoral dissertation study was made to investigate the effects of context and size of step to meaningful learning and retention in a linear instructional program, developed in accordance with the RULEG system, for 5th grade pupils. Among the variables explored were: (1) the mean number of acquisition errors; (2) the mean time required to complete the learning materials; and (3) the mean retention score for the recognition and meaningful information. A three-by-two factorial design was used. Relevant comparisons of the mean performances of all experimental groups were made. The study concluded that the sequencing of additional context statements in the form of advance organizers did not improve a linear instructional program; however the organization of facts into topics with context sentences did facilitate the retention of meaningful facts in the small size of steps condition despite the presence of interference. (WCM)

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EFFECTS OF CONTEXT AND SIZE OF STEP ON MEANINGFUL LEARNING AND RETENTION IN A LINEAR INSTRUCTIONAL PROGRAM

by

George Rowland McMeen

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To

Dr. C. Edward Meyers,

Dr. Edward B. Fry, and

Dr. Joseph W. Rigney,

who, during my association as a student-assistant with the Department of Educational Psychology and Electronics Personnel Research Group at the University of Southern California from 1961 to 1962, influenced my interest in programed instruction.

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CHAPTER I

THE PROBLEM

> As an ideal the active process of organizing facts and ideas is an ever-present educational process. No experience is educative that does not tend both to knowledge of more facts and entertaining of more ideas and to a better, a more orderly arrangement of them.
>
> John Dewey (1938)

Studies of programed instruction have been generally related to behavioral learning and not to certain aspects of the theory of meaningful learning such as the use of organizers to improve retention. A lack of interest in cognitive approaches to learning in behavioral research has been the consequence of a dichotomy of psychological theories, which Hebb (1949, p. 58) described as "connectionist" and "configurationist." This division has led to different viewpoints in programing about the locus of learning and the conditions which are essential for learning. On the one hand, the connectionist position, which is found in response-centered studies, emphasizes that no learning may be expected without performance and reinforcement. Holland (1960, p. 219) spoke for this view when he stated, "Behavior is learned only when it is

emitted and reinforced." On the other hand, Hatch (1961, pp. 76-77) reflected the configurationist outlook when he wrote, "Learning is presumed to take place at the point of information dissemination, prior to the response." This perspective may be seen in stimulus-centered programs, which are concerned with the perceptual organization of stimulus material. More attention has been given to research related to the connectionist position, and this fact explains why the use of organizers has not been studied in linear instructional programing.

Ausubel (1968, p. 137) states that communications to the learner in the form of advance organizers mobilize anchoring ideas within cognitive structures and facilitate the assimilation of new information under more inclusive, hierarchically arranged concepts. Two studies reported by Gagné (1969) and Gagné and Wiegand (1970) indicate that the presence of more inclusive context in organizers enhances this facilitation.

The use of organizers containing superordinate or coordinate context might improve the learning and retention of meaningful facts in a linear instructional program. An experiment involving such organizers and a programed sequence of potentially meaningful material might test the validity of Ausubel's (1968, pp. 348-349) view that a small step-size approach to programing substantive material is "empirically unsupportable."

Statement of the Problem

Gagné (1969) and Gagné and Wiegand's (1970) studies of context in meaningful learning and retention suggest the importance of using context statements, particularly superordinate ones, as advance organizers in potentially meaningful learning material constructed for fourth and fifth grade pupils. Ausubel's (1968) theory of meaningful learning, which underlies their research, stresses the importance of more inclusive and less general statements as a means of facilitating meaningful learning and retention through the mobilization of latent anchoring ideas in cognitive structures for the assimilation of subsequent information. If potentially meaningful material can be programed, the possible application of such organizers in a linear instructional program might be beneficial. Indeed, Ausubel's belief that small step-size in meaningful material is indefensible and the results of investigations by Gagné and Wiegand (1969; 1970) favoring the use of context offer a rationale for using shorter linear programs with advance organizers, even though studies of size of step (Coulson and Silberman, 1960; Evans, Glaser, and Homme, 1962) have shown small step-size to be an important factor. The possibility exists, however, that shorter linear sequences containing organizers and potentially meaningful facts to be remembered might not be as effective

as longer ones having small step-size, or that these organizers might not function effectively in the presence of smaller amounts of subordinate information in learning conditions which have large step-size. Despite these risks, the use of context in organizers might facilitate meaningful learning and retention in a linear sequence and reduce the amount of time required to complete a linear program.

The problem for this study is to investigate the effects of context and size of step on meaningful learning and retention in a linear instructional program, developed in accordance with the RULEG system (Evans, Glaser, and Homme, 1960), for fifth grade pupils. The following questions are aspects of this problem:

1. Does the sequencing of superordinate and coordinate context in the form of advance organizers in a linear instructional program facilitate meaningful learning and retention, and, if it does, is this facilitation reflected by a reduction in acquisition errors and completion time and an increase in retention scores?

2. Is superordinate context superior to coordinate context for facilitating meaningful learning and retention in terms of fewer acquisition

errors, shorter completion time, and higher retention scores?

3. How important are the possible organizing effects of context compared to size of step?

Importance of the Problem

This problem is important from the standpoint that (a) shorter programs might be written if advance organizers facilitate the meaningful learning and retention of propositional material in linear sequences and (b) patterns of hierarchical organization might be considered for the application of context statements to sequences. An analysis of data collected for this problem might suggest a need for further investigation related to context organization and the possible existence of size of step limits governing the number of subordinate ideas which advance organizers may effectively subsume.

Objectives of the Study

The objectives of this study were to examine the effects of advance organizers, context, and size of step in improving the learning and retention of meaningful verbal material in a linear program. The use of organizers in small-step learning conditions raised the possibility that any repetitious or redundant frames in the program might interfere with meaningful learning and retention.

In order to consider the effects of advance organizers (containing superordinate and coordinate context), size of step, and possible retroactive interference, the specific objectives were:

1. To determine the effectiveness of a linear instructional program with advance organizers compared to a program without organizers in terms of acquisition errors, completion time, and retention scores.
2. To determine the relative effectiveness of superordinate and coordinate context sentences as advance organizers in a linear program in terms of acquisition errors, completion time, and retention scores.
3. To investigate the relationship in a linear program between context sentences as organizers and size of step in terms of acquisition errors, completion time, and retention scores.
4. To determine the extent of any possible interference resulting from the use of context sentences as organizers and the presence of any repetitious or redundant frames in the linear program.

The Experiment

This study consisted of an experiment involving 78 fifth grade pupils in a 3 X 2 factorial design having two variables, context and size of step. Three treatment levels were present for the first variable, context. They were superordinate context (topic sentence), coordinate context (related sentence), and no context. Two treatment levels for the second variable, size of step, were large and small step-size. The six different learning conditions which were investigated were the following: (a) superordinate context and large step-size; (b) coordinate context and large step-size; (c) no context and large step-size; (d) superordinate context and small step-size; (e) coordinate context and small step-size; (f) no context and small step-size (control group). Data were collected for acquisition errors made in answering response blanks in the learning materials, time required to complete the various learning conditions, and retention scores for the recognition and recall of meaningful information to be remembered.

Hypotheses To Be Tested

This investigation is based upon the following hypotheses:

1. The mean number of acquisition errors made by the experimental subjects in completing the learning materials in the no context groups having large or small size of step will be significantly larger than that of the superordinate or coordinate context groups in either corresponding size of step condition.

2. The mean time required by the experimental subjects to complete the learning materials in the superordinate or coordinate context groups having large or small size of step will be significantly larger than that of the no context group in either corresponding size of step condition.

3. The mean retention scores for the recognition and recall of meaningful information will be significantly higher for the experimental subjects in the superordinate and coordinate context groups having large or small size of step than that of the no context group in either corresponding size of step condition.

4. The main retention scores for the recognition and recall of meaningful information will be significantly higher for the experimental

subjects in the superordinate context groups having large or small size of step than that of the coordinate context group in either corresponding size of step condition.

5. The mean retention scores for the recognition and recall of meaningful information will be significantly higher for the experimental subjects in the superordinate context group having large size of step than that of the no context group in the small size of step condition.

Definitions of Terms Used

The following definitions are offered to clarify the terms used in this study:

Meaningful learning. The type of learning that occurs when the learner encounters substantive instead of verbatim aspects of new concepts, information, or situations and incorporates them into his cognitive structure through subsumption (Ausubel, 1963, p. 22).

Subsumption. The principal mode of relating new ideas in potentially meaningful material to established concepts in cognitive structure (Ausubel and Robinson, 1969, p. 47).

Retention. The quality of initial learning of

meaningful material that is substantive rather than verbatim (Ausubel, 1963, pp. 51-53).

Cognitive structure. The intellectual capacities, ideational content, and experiential background of memory (Ausubel, 1963, pp. 22-23).

Meaningful material. Substantive information which is capable of being related to relevant, established concepts in cognitive structure (Ausubel, 1963, pp. 22-23).

Advance organizer. The communication to the learner that draws upon and mobilizes relevant subsuming concepts previously established in his cognitive structure (Ausubel, 1960).

Context. The presence of an additional set of ideas relating facts to be learned to subsuming concepts.

Coordinate context. The type of context in which parallel or related ideas are equivalent in terms of generality and inclusiveness to the facts to be remembered (Gagné and Wiegand, 1970).

Superordinate context. The type of context in which ideas are more general and inclusive than the facts to be remembered (Gagné and Wiegand, 1970).

Interference. The inhibition of material to be remembered.

Retroactive interference. The greater than

expected loss of retention attributed to the effect of interpolated material. It may occur when the subject learns material "A" before material "B" and is subsequently retested on his knowledge of "A" (Ausubel and Robinson, 1969, p. 120).

Linear instructional program. The form of instructional programing which is usually characterized by an ordered sequence, small step-size, few acquisition errors, a constructed response for each frame, and immediate knowledge of results. It provides an exact, predetermined sequence for the learner to follow regardless of the correctness of his response.

RULEG. A system for writing linearly programed instructional sequences. It entails the use of statements and examples which may be positive or negative. An incomplete rule or an incomplete example is present in each frame.

Size of step. The magnitude of learning difficulty involved in proceeding from one frame to another in a program. It is represented by the number of frames per concept.

Basic Difficulties Underlying the Problem

Certain difficulties pertained to this study. The first one concerned the availability of subsuming concepts within the cognitive structures of fifth grade pupils and

the mobilization of these ideas as anchoring points for the sumsumption of new material. Though such concepts were assumed to be present, randomization of the assignment of treatments to subjects assured that any conceivable deficiency would be evenly distributed among all experimental groups.

The second difficulty involved the validity of the criterion test as a measure of the retention of meaningful facts. This difficulty was only resolved by assuming that meaningfulness might be assessed by the following types of questions: (a) multiple-choice recognition of a paraphrased fact to be remembered having completion blank(s) for the recall of missing key word(s); (b) multiple-choice recall of the missing key word(s) in this concept; (c) true-false recognition of an example of this concept. Recognition and recall of the facts to be remembered was an important measure of retention in two earlier studies of context (Gagné, 1969; Gagné and Wiegand, 1970).

Statement of Assumptions

The following assumptions emanated from a consideration of the theoretical orientation of this study:

1. Meaningful learning occurs as the learner encounters potentially meaningful ideas and assimilates them into his pre-existing cognitive structure.

2. Advance organizers facilitate meaningful learning and retention by mobilizing inclusive concepts which act as anchoring ideas for the subsumption of potentially meaningful material.
3. Variants of previously learned concepts which are discriminable to the learner have long-term retention potentialities.
4. Subsuming concepts are available in the learner's cognitive structure.
5. Interference in learning and retention may take place when similar cognitive elements are closely related.
6. Potentially meaningful material may be programed without weakening the substantive interaction of new ideas and established concepts in cognitive structure.
7. Step-size may be increased within a linear program by eliminating frames which are repetitious and redundant.
8. The facts to be remembered in the learning material were substantive and potentially meaningful.
9. A test instrument consisting of recognition

and recall questions is a valid measure of meaningful learning and retention.

10. Absence of a topic sentence as a cue preceding certain test questions will not affect the retrieval of meaningful facts in the superordinate condition.

This investigation departed from the procedure established in previous studies (Gagné, 1969; Gagné and Wiegand, 1970) in which the topic sentence used in the superordinate context learning condition also appeared as a test cue.

Organization of the Research

The following order of chapters has been adopted so that the content of the investigation will be integrated in a logical manner. Chapter II will review the literature concerning meaningful learning, context, size of step and interference. Chapter III will describe the methodology of the study. Chapter IV will report the study's findings. Finally, Chapter V will provide a summary of these findings, discuss their implications, draw conclusions, and make recommendations.

CHAPTER II

SURVEY OF THE LITERATURE

> Attentive care must be devoted to the conditions which give each present experience a worthwhile meaning.
>
> John Dewey (1938)

A survey of the literature on meaningful learning, context, and size of step is necessary to find a possible basis for supposing that hierarchical forms of context in advance organizers might have differential effects on retention in a linear instructional program and that the application of these organizers might have a bearing upon considerations of appropriate step-size.

Meaningful Learning

Meaningful learning is the outcome of a particular learner's encounter with new propositions containing potentially meaningful ideas (Ausubel and Blake, 1958). New material becomes meaningful as the mind progressively differentiates it under conceptual clusters in cognitive structure which are arranged according to their degree of inclusiveness. For learning to be meaningful, relevant subsuming concepts must be mobilized (Ausubel, 1960; Ausubel and Fitzgerald, 1961), and they must be stable and

clear (Ausubel and Fitzgerald, 1962).

This form of reception learning presupposes a learning set in which the learner is disposed to subsume potentially meaningful material. It is characterized by the presence of substantive instead of verbatim aspects of new concepts, information, or situations presented as propositions. This information may be related in derivative, elaborative, correlative, supportive, qualifying, or representational ways to established ideas (Ausubel, 1963, p. 22).

A distinction should be drawn between the terms "potentially meaningful" and "meaningful." If material has not been introduced to the learner, it may be potentially meaningful if it is substantive and capable of being related to relevant concepts in cognitive structure. Meaningful material, however, has been assimilated by the learner, and it is no longer distinguishable as information to be learned. Once it has been subsumed, it may be called meaningful, because meaningfulness reflects this assimilation.

Meaningful learning theory assumes that cognitive structure is hierarchically organized from greater to lesser inclusiveness. Highly stable and inclusive concepts which are established in this structure subsume subconcepts and more specific illustrative data. The subsumption process progressively differentiates experience

from greater to lesser inclusiveness and links concepts and more factual data according to their differentiation. Thus subordinate information is progressively less inclusive and more differentiated. Subsumption provides the basis for meaningful learning and later forgetting. It replaces a larger number of more specific and less general data with a single inclusive concept when meaningful material enters the learner's cognitive field. This is a more economical and orderly way of arranging information. Obliteration or forgetting inevitably occurs as the more generalized meaning of a concept encompasses the import of less inclusive material and makes specific items less dissociable from their subsumers.

The presence of communications to the learner in the form of advance organizers improves meaningful learning and retention (Ausubel, 1960). The facilitating effect of organizers is reported to be greatest for students who have relatively poor verbal ability and are less able to organize learning material effectively (Ausubel and Fitzgerald, 1962). Organizers are particularly advantageous in the sense that they decelerate the process of obliteration by dissociating propositions from their anchoring ideas and relating new material to previous understandings.

Context

Context material may be used to enhance learning and retention. Even text-embedded questions have positive effects (Rothkopf and Bisbicos, 1967). The only disadvantage of context appears in rote learning, where a context of similar materials causes interference (Keppel, 1968). However, different processes underlie rote learning and meaningful learning, and the positive effects of using context in organizers in meaningful situations seem to more than compensate for any possible adverse effects.

Ausubel and Fitzgerald (1961) and Ausubel and Youssef (1963) investigated correlative or coordinate ideas in context statements used as organizers and noted positive effects for correlative context. Ausubel's (1967) emphasis upon the importance of "subsuming" and "correlative" contexts prompted subsequent studies (Gagné, 1969; Gagné and Wiegand, 1970) which pointed to the superiority of subsuming or superordinate context for the retention of facts. Organizers which had superordinate context possessed greater generality and inclusiveness and mobilized anchoring ideas which were located higher in cognitive structure and were more resistant to obliteration.

Using potentially meaningful material, Gagné (1969) examined context effects under conditions which

revealed the operation of organizing factors and interference in determining retention. His study indicated the relative superiority of superordinate context to coordinate and unrelated contexts, but it also showed that the absence of context was superior to any of these conditions. This unexpected finding may be explained in terms of interference and familiarity. Remembering extra facts in the form of context statements may have interfered with the retention of the main facts to be remembered in the context conditions, thereby making "no context" appear significantly better. Retention, which had been considerably less in a previous study of minimal familiarity using nonsense components of concepts and facts (Gagné and Wiegand, 1968), was much greater in this experiment. The presence of facts to be learned and relational concepts that included familiar attributes of concepts may explain this difference.

In a study of superordinate and coordinate context, Gagné and Wiegand (1970) employed explicit directions to orient the learner toward topic sentences in the superordinate condition. Previously, Wittrock (1963) had investigated the role of such directions as a set to learn. In both context conditions, single sentences were utilized as context statements and as cues before recall and recognition. Significantly greater remembering occurred in the superordinate condition with a major effect in the

retrieval of information during the remembering process.

The experiments of Gagné (1969) and Gagné and Wiegand (1970) indicate the superiority of superordinate context in advance organizers despite the fact that "no context" appeared better when interference and familiarity were involved in the context conditions. Organizers draw upon established concepts in cognitive structure and mobilize them as anchoring points for the subsumption of meaningful facts to be learned. Superordinate ones do this to a higher degree, and they have a greater facilitative effect upon meaningful learning and retention than other forms of context statements.

A possible relationship between context and size of step has not been examined in terms of meaningful learning and retention. Meaningful learning theory defines a step as a new increment of knowledge which is an anchoring post for subsequent learning (Ausubel and Fitzgerald, 1962). Definitions of step-size in programed instruction are not necessarily incompatible with this explanation although early behavioral insistence upon small steps and a low error rate is incongruous with the substantive emphasis of meaningful learning, and less important in relation to the need for stability and clarity in organizers and the relevance of organizers to established concepts.

Size of Step

There are many definitions present in the literature for size of step as well as disagreement about optimal step-size. Definitions vary but they generally pertain to some aspect of step-size such as the number of frames in a program, the amount of progress toward a goal represented in one frame, the time it takes to respond, the difficulty in making a correct response, or the frequency of reinforcement. Certain assumptions underlie these interpretations. For example, Skinner (1958) believed in the efficacy of small steps. He prescribed that each step should be small enough to be always taken and that it should move the learner closer to fully competent behavior. To Holland (1960), who shared this view, a gradual progression of small steps offered the fastest way of attaining a complex repertoire. Despite the persuasiveness of small steps, Gilbert (1962) advocated larger rather than smaller ones on the basis that they would permit a faster determination of the difficulty of a particular program for a given student.

Several definitions of size of step have been included in studies of programing. Viewing step-size as a function of program length, Coulson and Silberman (1960) constructed programs with different numbers of frames by

removing items that they considered redundant from a small-step program. They observed a posttest advantage for the longer, small-step version and noted that it required significantly more time. Evans, Glaser, and Homme (1962) obtained similar results when they created different versions by taking a short program and eliminating or adding material. The items which they removed were judged to be redundant and transitional. Approaching step-size from the number of errors in a program or the "difficulty of giving the correct answer," Shay (1961) studied a possible relationship between intelligence and step-size in learning but found no significant differences. In an investigation of anxiety and program difficulty reported by Silberman and others (1962), a failure to make both large- and small-step versions sufficiently dissimilar, even though they differed in terms of their length, seemed to account for nonsignificant findings. Gagné and Bassler (1963) and Hamilton and Porteus (1965) found significantly better post-program retention in the use of a greater number and variety of examples in programed material although their programs had wide varieties of responses and were called small-step sequences.

Furukawa (1970) combined step-size with learning ability to describe "chunking." A chunk was a measure of the number of correct responses that might be elicited from the learner's memory after a single exposure to

verbal materials. It implied a fixed memory capacity. In applying this term to word associations, he discovered that programed large-step conditions were more effective than small-step ones. Continued rehearsal in the large-step condition and some interference in smaller steps may have accounted for this paradoxical finding, but there was a stronger reason. Every seven frames of his large-step program corresponded with an internal structure in the material favoring the acquisition of groups of word associations and facilitating storage and subsequent recall. However, his experiment did not deal with substantive material and meaningful learning. Therefore, the appropriateness of chunking as a definition for size of step in studies of meaningful learning and retention is uncertain but worth investigating.

Interference

In paired-associate learning of word lists, interference is a critical consideration for optimizing practice conditions (Underwood, 1964). Although Hall (1955) reported that meaningful material and nonsense material were not subject to interference to the same degree, interference is a definite concern for a small-step program in which the similarity of ideational elements in subsuming and learning materials and in repetitious or redundant items might produce adverse effects. Entwisle and

Huggins (1964) found evidence of retroactive interference in a meaningful learning experiment using "dual topics" in electrical circuit theory.

In investigations of rotely learned verbal material, similarity between original learning and interpolated learning tends to result in retroactive inhibition when it deviates more than slightly from identity (Hall, 1955; Keppel, 1968; Osgood, 1953; Slamecka and Ceraso, 1960). Studies of the effect of similarity between original and interpolated learning on the retention of meaningfully learned prose materials have produced conflicting results. For example, some investigations have disclosed a possible inhibition effect (Ausubel, Robbins, and Blake, 1957; Ausubel, Stager, and Gaite, 1968; Wong, 1970). Others have not observed statistically significant data for a facilitation although differences in scores have suggested such an effect (Gaite, Ausubel, and Stager, 1969; Shuell and Hapkiewicz, 1969). In addition, earlier studies of prose and retroactive inhibition (McGeoch and McKinney, 1934; Mehler and Miller, 1964) have revealed that poorer performance resulted from similar interpolated learning, but they lacked statistically significant evidence for this effect. Thus similarity in original and interpolated learning is implicated as a factor leading to retroactive inhibition, and interference is a possible occurrence in a small-step program.

Summary

Gagné's (1969) finding that a condition without context was best for retention is unusual. Meaningful learning theory implies that this would be an unexpected occurrence under meaningful circumstances. In the use of context in meaningful learning, studies indicate that organizers with superordinate context have a greater facilitative effect for meaningful learning and retention than ones containing coordinate context and unrelated context. Explicit instructions to students to notice organizers may also be important.

Investigations of size of step reflect a trend away from a special rationale for short frames and small size of step. Small steps may be unnecessary in meaningful prose materials if context statements in organizers will facilitate the learning and retention of linearly programed, potentially meaningful material. Redundancy or repetition among items and the similarity of original and interpolated learning materials may facilitate retroactive inhibition, but such interference may be a relatively unimportant factor compared to the positive effects which the use of context may have for meaningful learning and retention in linear instructional programing.

CHAPTER III

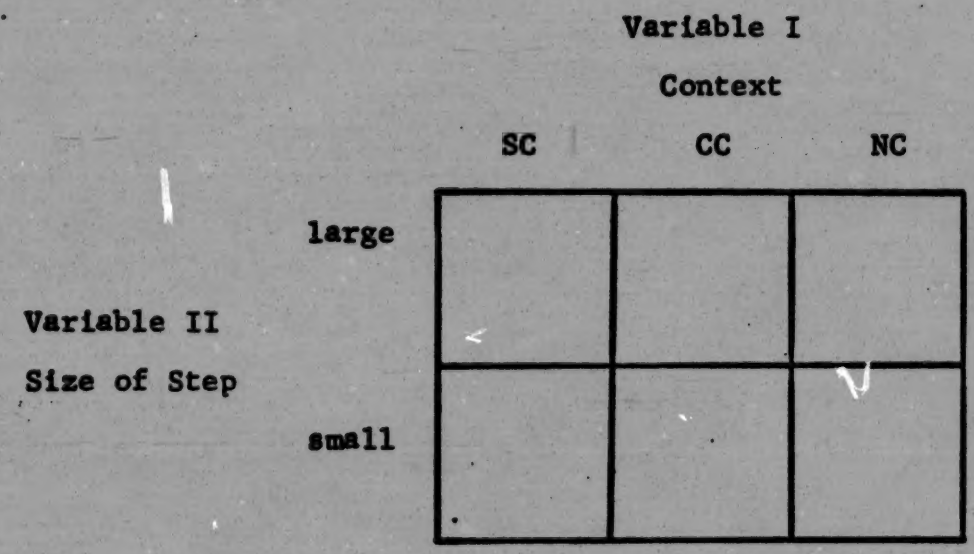
EXPERIMENTAL DESIGN

> If we are to further our understanding of human behavior and to improve our practices of control, we must be prepared for the kind of rigorous thinking which science requires.
>
> B. F. Skinner (1953)

This study utilized the three by two factorial design shown in Figure 1 to investigate the influence and interaction of two variables, context and size of step. The context variable consisted of three levels, superordinate and coordinate contexts and no context, while the size of step variable had two levels, large and small. In this posttest only control group experiment, subjects in the no context and small step-size condition formed the control group. Relevant comparisons of the mean performances of all experimental groups were made for acquisition errors, completion time, and retention scores.

Sample

The sample consisted of 78 pupils in the fifth grade of an elementary school located in a primarily middle-class suburban community. This school, which had a total enrollment of 820 pupils, was one of nineteen



Note: The following abbreviations represent levels of context:

SC = Superordinate context
CC = Coordinate context
NC = No context

FIGURE 1

RESEARCH DESIGN

elementary schools in a rapidly growing school district in the Los Angeles area. The subjects in this experiment were drawn from three fifth grade classes. Two other classes which were not included in this study contained five "educationally handicapped" pupils and ten pupils assigned to a remedial group of fourth and fifth graders on the basis of low achievement in mathematics.

This sample was similar in some ways to the samples used by Gagné and Wiegand. For instance, the number of experimental subjects involved was not large. In a study of context and retention, Gagné (1969) included 56 pupils in the fourth grade and 56 pupils in the fifth grade, and he selected 62 pupils from the fourth grade of another school in a related experiment with Wiegand (1970). These pupils also attended schools which were located in middle-class suburban communities. However, Gagné and Wiegand identified the range of IQ scores and median IQ for their samples by collecting data from school records of traditional group tests. The use of scores from different tests is not above criticism. The present investigation did not utilize similar information when it observed that the IQ scores for its sample were likewise obtained from different measures of intelligence.

The assignment of experimental subjects to treatment conditions in this study differed from Gagné and Wiegand's procedures. This investigation randomly assigned

an initial group of 80 fifth graders to its experimental conditions without regard to specific IQ scores. Gagné and Wiegand randomly assigned their subjects within different IQ levels to various conditions in both of their experiments. The former procedure assured that intelligence factors would be approximately equal in all experimental groups, while the latter equalized these factors within specific IQ levels. Absences in the initial groups in these studies and the present one were handled by randomly discarding cases from samples so that an equal number of subjects could be apportioned to each treatment cell in respective experimental designs.

Learning Material

This investigation closely follows Gagné (1969) and Gagné and Wiegand's (1970) use of learning material. The instructional material which was employed is based upon Gagné's science lesson about howler monkeys. This lesson contained the following five potentially meaningful facts to be remembered:

A. Young howler monkeys wrestle and chase each other in play.

B. Mother howler monkeys carry their babies with them wherever they go.

C. Howler monkeys roar and throw objects at animals they are afraid of.

D. A howler monkey uses his tail as another hand.

E. Howler monkeys prefer to live in forests of tall trees.

These facts were programed using the RULEG system outlined by Evans, Glaser, and Homme (1960). Each fact was stated as a rule and accompanied by two examples in the first frame of each concept sequence. Thus the five beginning frames, corresponding to the above facts, were:

A. Young howler monkeys wrestle and chase each other in play. One howler monkey may grab another and tumble him. Howlers run when they ch_____ each other.

B. Mother howler monkeys carry their babies with them wherever they go. A mother howler usually has just one baby. This howler baby holds on to his m_____.

C. Howler monkeys roar and throw objects at animals they are afraid of. Howler leaders warn away other tribes of monkeys. Howlers sometimes throw things within their reach at animals they are _____ of.

D. A howler monkey uses his tail as another hand. A howler monkey can grip things with his tail. A howler can eat with a hand or foot while

he hangs by his t_____.

E. Howler monkeys prefer to live in forests of tall trees. Howlers travel through trees. They howl and roar from t_____.

Each of these frames contained the essential information to be learned within the lesson. Taken together, they formed the large-step, five frame linear instructional program (without added context sentences). Each one was also the beginning of a concept sequence of six frames in the small-step version. The following sequence illustrates how potentially meaningful information was typically developed and ordered in the lengthier small-step program. Note that Frame A in the preceding example is the first frame of this sequence and that each frame corresponds to a particular stage of frame development found in the RULEG system.

1. Young howler monkeys wrestle and chase each other in play. One howler monkey may grab another and tumble him. Howlers run when they ch_____ each other. (RU + EG + $\widetilde{EG}$)

2. Young howler monkeys may sometimes make each other fall when they wrestle. They almost seem to play tag when they ch_____ each other. (EG + $\widetilde{EG}$)

3. Young howler monkeys may push each other off balance when they wr_____. (EG)

4. Young howler monkeys wrestle and _____ each other in play. (RU)

5. Young howler monkeys may play a little roughly when they wrestle. Howlers like to run after each other. They enjoy playing games when they are young. Young howler monkeys _____ and chase each other in play. (EG + EG + EG + RU)

6. Young howler monkeys _____ and _____ each other in play. (RU)

In the foregoing sequence, a rule is designated by "RU" and an example, "EG." A tilde above an RU or EG stands for a response blank.

All of the RULEG sequences were developed from Gagné's five main facts to be remembered and not from other sentences in his prose topics of howler play, mother-child relationships, actions toward enemies, the howler's tail, and forest living. The RULEG system offered a means of carefully controlling the number of frames for each concept by analyzing verbal subject matter into rules and examples (Markle, 1964, p. 97). Within concept sequences, examples were subordinate to rules since they contained less inclusive and more specific information. These

sequences are presented as the linear instructional program in Appendix A.

The subsuming materials in this study were related to those used by Gagné and Wiegand. The same superordinate context sentences were employed, but the coordinate context ones were not identical although they were similar. These superordinate and coordinate context sentences appear as Appendices B and C respectively. This investigation did not consider the effect of superordinate sentences as context cues for retrieval as Gagné and Wiegand (1970) had. These topic sentences appeared only in the superordinate learning condition and not in testing.

Instructions to the learners were written for the treatment groups. These directions differed in the following way: One set of instructions told the subjects that they should read any frame containing a sentence before reading and responding to a frame having a question. The other set told them to expect only frames having questions, which they were to answer.

Retention Test

Twenty questions for the test instrument were constructed to measure the substantive rather than verbatim retention of facts to be remembered, which were found in the first frame of each RULEG sequence. They provided two different scores: (a) recognition of the main facts and

their examples, and (b) recall of their substance. Presumably, these questions assessed substantive retention because they contained paraphrases of facts to be remembered and their examples. They were organized into the following three groups: (a) recognition of a paraphrased rule, (b) recall of that rule's substance, and (c) recognition of a paraphrased example. None of these groups measured the recognition of paraphrased context statements because the same context sentences did not appear in all treatment conditions.

Half of the questions in the test dealt with the recognition of a paraphrased rule or recall of its substance. In these items, the experimental subjects had to recognize the correct paraphrase of the main fact or rule (recognition) in a group of four multiple-choice items and then complete one or more response blanks with a multiple-choice answer for one or more missing key words (recall). The other half comprised true-false questions, which provided an additional measure of meaningful learning and retention. These items required the subjects to recognize paraphrased examples (recognition), and they gave no indication of how other questions might be answered. This test and its accompanying instructions are presented as Appendix D.

This test instrument was similar in format to Gagné (1969) and Gagné and Wiegand's (1970) measure of

recognition and recall. The test was constructed as a six-page booklet in which the first page gave instructions and the remaining five pages contained four questions each. Subjects had to choose the best answer from each four-item multiple-choice question for rule recognition and recall by circling the appropriate letter in front of their choice. For recognition of an example, they had to select the correct response: "A" for True or "B" for False. The order of correct responses within all questions was randomized. Instructions were improved over those used in an earlier field trial. Specific examples of each type of question and how to answer it were presented in written form rather than given orally. These examples contained unrelated information about traffic lights.

Field Trial

A field trial of the learning material and the retention test was conducted in a neighboring middle-class suburban school district bordering the district in which the experiment was conducted. The sample for this trial consisted of 25 pupils in one fifth grade class at an elementary school that had a total enrollment of 720 pupils.

Data for acquisition errors, completion time, and retention of meaningful material were collected. An item analysis of the learning material indicated that the

linear instructional program had an error rate consistent with Galanter's (1959) recommendation of less than ten percent. Finally, a reliability coefficient of +.80 was determined for the test of recognition and recall using the test-retest method with a one-week interval.

Procedures

This study did not adopt Gagné (1969) and Gagné and Wiegand's (1970) procedure of placing learning material on slides which were projected on a screen and accompanied by audio tape. The linear instructional program appeared as printed material which had been xeroxed. The learning material in the earlier investigations was projected on a screen and read to experimental subjects for a time interval of 5 seconds (± 1 second) for each slide. No restrictions were placed upon the amount of time that a pupil could spend on any frame in this study's linear program. Subjects were permitted to progress at their own rates. They were told, however, not to reread any material after they had responded. When they finished, they completed unrelated crossword puzzles which followed the end of the linear program. They believed that these puzzles were part of their instructional task, and they spent the remainder of the class period answering them.

In the superordinate context learning condition,

a brief remark, "This sentence tells what the next few are all about," introduced each superordinate context sentence just as it had in Gagné and Wiegand's experiments. This statement was similarly absent in the coordinate learning condition.

The procedure for presenting the learning material to the experimental subjects differed from Gagné and Wiegand's method. Their subjects began by watching a slide-tape introduction which was immediately followed by a series of verbal propositions (using the same medium) about howler monkeys. The change was not mentioned, and subjects were probably unaware of the transition. This procedure was not adopted by the present study. Instead, the linear instructional program was introduced by means of printed verbal instructions, which could be observed to be different.

This study observed Gagné and Wiegand's procedure of not mentioning that the learning material would be followed by a retention test. All subjects read their learning material on the same day and completed it in one class period. Two days later, they received the retention test. The purpose of the study was only explained to them after each class had finished.

Treatment of Data

Data were collected for acquisition errors and

completion time in the linear instructional program and for retention test scores, representing the recognition and recall of meaningful facts and the recognition of related examples. These data were analyzed using: (a) a two-way analysis of variance to examine achievement with respect to the main effects and interactions of context and size of step, and (b) the Newman-Keuls test for multiple comparisons of the ordered means within each set of data for each treatment group.

CHAPTER IV

ANALYSIS OF EXPERIMENTAL DATA

> The principles governing the nature and conditions of meaningful, verbal reception learning can be discovered only through an applied or engineering type of research that actually takes into account the distinctive attributes of this phenomenon as it occurs in the classroom.
>
> David P. Ausubel (1963)

Acquisition Error Data

A two-way analysis of variance was performed on the data for acquisition errors (Table 1). The main effect of the context variable was nonsignificant, while the effect of the size of step variable was significant ($F = 7.29$, $df = 1$, $p < .01$). The interaction effect of context and size of step, shown in Figure 2, was nonsignificant even though lines S_1 and S_2 for size of step are not parallel.

Application of the Newman-Keuls test to the acquisition error means of the treatment groups reveals nonsignificant differences despite the significance of size of step. The test data in Table 2 do not support the first hypothesis that the mean number of acquisition errors for the no context groups would be significantly

TABLE 1

OUTCOME OF THE TWO-WAY ANALYSIS OF VARIANCE: ACQUISITION ERRORS

Source	df	SS	MS	F
Context (A)	2	2.39	1.20	-
Size of Step (B)	1	18.52	18.52	7.29*
A X B	2	3.56	1.78	-
Within	72	183.15	2.54	

*$p < .01$.

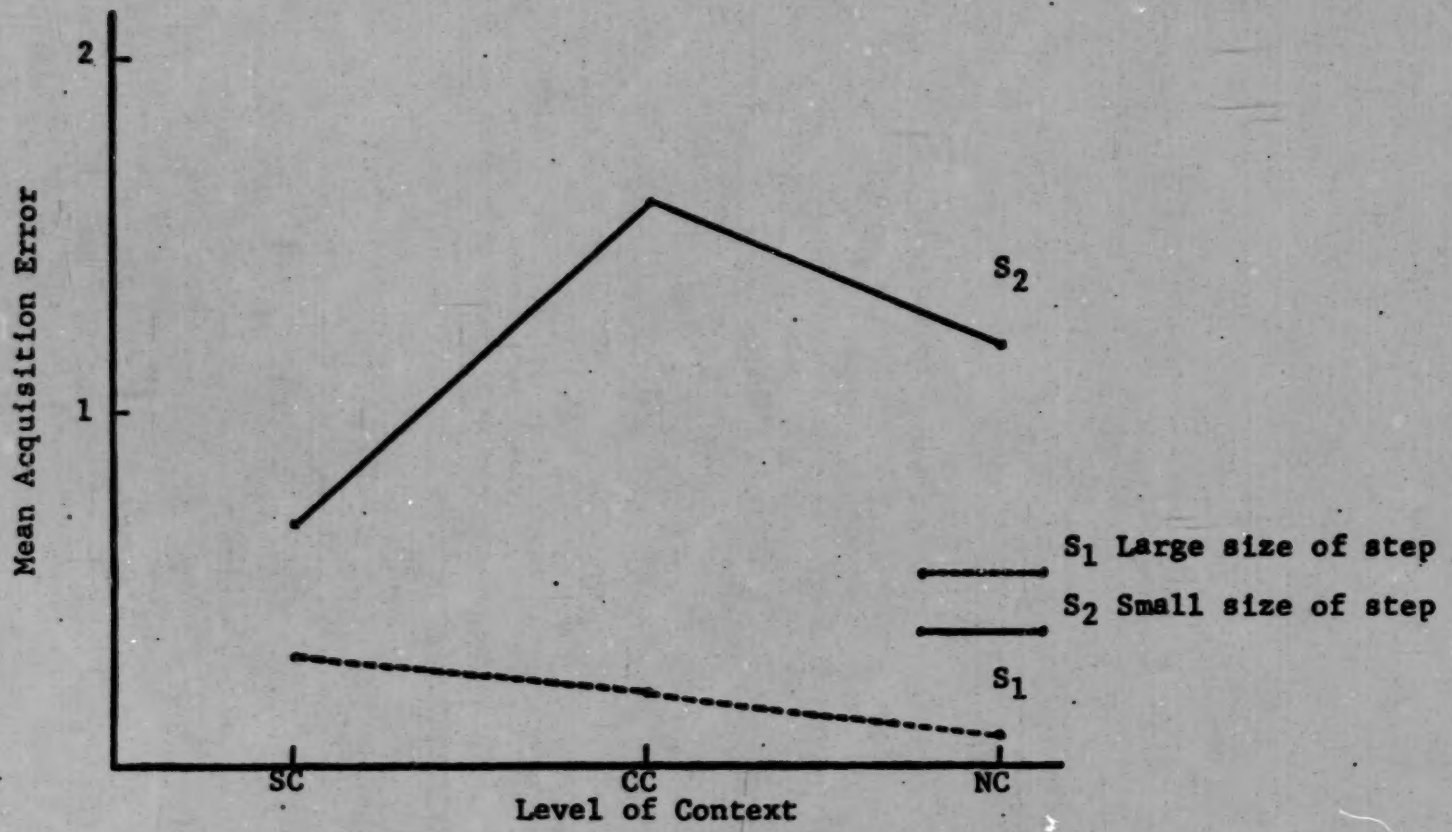


FIGURE 2

INTERACTION EFFECT: TWO-WAY ANALYSIS OF VARIANCE FOR ACQUISITION ERRORS

TABLE 2

OUTCOME OF THE NEWMAN-KEULS TEST:
ACQUISITION ERRORS

	$\bar{X}_3$	$\bar{X}_2$	$\bar{X}_1$	$\bar{X}_4$	$\bar{X}_6$	$\bar{X}_5$
$\bar{X}_3 = 0.08$	-	0.15	0.23	0.61	1.15	1.54
$\bar{X}_2 = 0.23$		-	0.08	0.46	1.00	1.39
$\bar{X}_1 = 0.31$			-	0.38	0.92	1.31
$\bar{X}_4 = 0.69$				-	0.54	0.93
$\bar{X}_6 = 1.23$					-	0.39
$\bar{X}_5 = 1.62$						-

*$p < .05$

$$W_r = q_r\sqrt{MS_{error}/n}$$

$$W_2 = 2.82\sqrt{2.54/13} = 1.24$$

$$W_3 = 3.39\sqrt{2.54/13} = 1.49$$

$$W_4 = 3.73\sqrt{2.54/13} = 1.64$$

$$W_5 = 3.97\sqrt{2.54/13} = 1.75$$

$$W_6 = 4.15\sqrt{2.54/13} = 1.83$$

higher than those of the other context groups at corresponding step-size levels. The data for mean acquisition errors in Table 3 indicate that the control group had more errors than the superordinate context and small-step group but fewer errors than the coordinate context and small-step one. In the large size of step condition, the no context group had fewer errors than the superordinate and coordinate context groups. Although the larger numbers of acquisition errors in the small-step groups were related to the greater number of response blanks in the small size of step learning materials, the mean number of errors for the superordinate and small-step group was smaller than those of corresponding coordinate and no context groups (cf. line S_2, Figure 2). The mean differences in the performance of the experimental subjects at the three levels of context in the large-step conditions were nonsignificant, but they indicated that superordinate and coordinate groups had slightly more errors than no context. Differences among the large-step treatments were small, yet they pointed to a gradual increase in errors (line S_1, Figure 2) across the context levels, with superordinate context having slightly more errors than no context. This same trend was not reflected in the small-step level, where coordinate context had a higher mean number of acquisition errors. In terms of the acquisition error data, the treatment conditions may be arranged in

TABLE 3

MEANS FOR ACQUISITION ERRORS

	Context		
	SC	CC	NC
Size of Step:			
Large	0.31	0.23	0.08
Small	0.69	1.62	1.23

Note: The following abbreviations represent levels of context:

SC = Superordinate context
CC = Coordinate context
NC = No context.

the following order: (a) large-steps--superordinate context > coordinate context > no context, and (b) small-steps--coordinate context > no context > superordinate context.

Completion Time Data

A two-way analysis of variance was applied to the data representing completion time. A high degree of significance appeared for the main effect of size of step ($F = 59.37$, $df = 1$, $p < .0005$) and the interaction effect of context and size of step ($F = 12.27$, $df = 2$, $p < .0005$) as shown in Table 4. The main effect of context was not significant.

Performing the Newman-Keuls test on the ordered means of the time data (Table 5) disclosed significant differences for all small size of step conditions compared to those having large step-size. These differences were significant at the .01 level. However, they were not unexpected since the small-step treatments were considerably longer than the large-step ones (cf. Table 6).

The second hypothesis, which indicated that superordinate and coordinate context groups in both size of step levels would require significantly more time than corresponding no context groups, was not supported although lines S_1 and S_2 in Figure 3 show that superordinate and coordinate context groups took longer to complete

TABLE 4

OUTCOME OF THE TWO-WAY ANALYSIS OF VARIANCE: COMPLETION TIME

Source	df	SS	MS	F
Context (A)	2	147.10	73.55	2.24
Size of Step (B)	1	1,946.78	1,946.78	59.37*
A X B	2	804.34	402.17	12.27*
Within	72	2,361.23	32.79	

*$p < .0005$

TABLE 5

OUTCOME OF THE NEWMAN-KEULS TEST:
COMPLETION TIME

	$\bar{X}_3$	$\bar{X}_2$	$\bar{X}_1$	$\bar{X}_6$	$\bar{X}_4$	$\bar{X}_5$
$\bar{X}_3$ = 3.31	-	0.77	3.15	10.46*	13.38*	15.23*
$\bar{X}_2$ = 4.08		-	2.38	9.69*	12.61*	14.46*
$\bar{X}_1$ = 6.46			-	7.31*	10.23*	12.08*
$\bar{X}_6$ = 13.77				-	2.92	4.77
$\bar{X}_4$ = 16.69					-	1.85
$\bar{X}_5$ = 18.54						-

*$p < .01$

$$W_r = q_r\sqrt{MS_{error}/n}$$

$$W_2 = 3.75\sqrt{32.79/13} = 5.85$$

$$W_3 = 4.26\sqrt{32.79/13} = 6.65$$

$$W_4 = 4.57\sqrt{32.79/13} = 7.13$$

$$W_5 = 4.80\sqrt{32.79/13} = 7.49$$

$$W_6 = 4.97\sqrt{32.79/13} = 7.75$$

TABLE 6

MEANS FOR COMPLETION TIME

	Context		
	SC	CC	NC
Size of Step:			
Large	6.46	4.08	3.31
Small	16.69	18.54	13.77

Note: The following abbreviations represent levels of context:

SC = Superordinate context
CC = Coordinate context
NC = No context

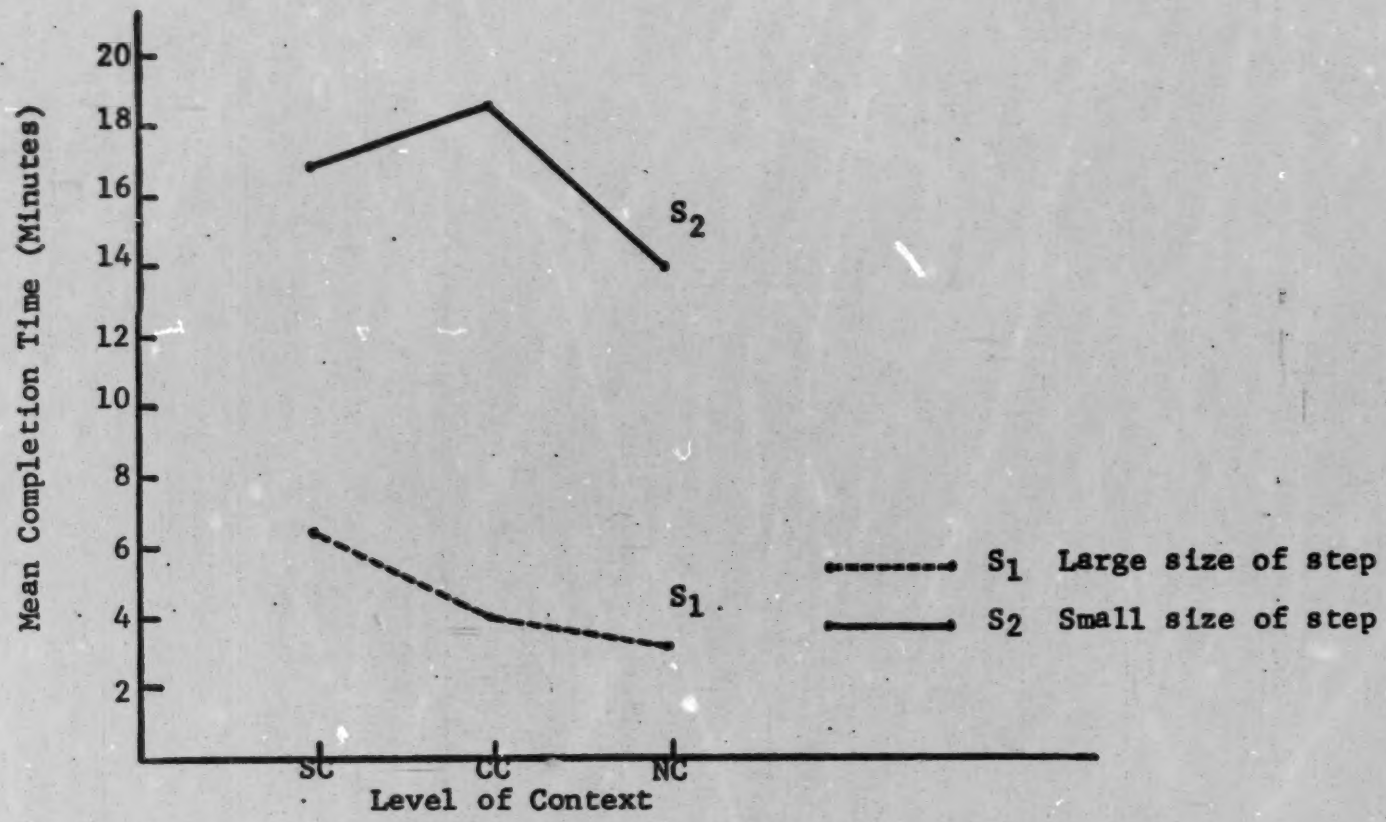


FIGURE 3

INTERACTION EFFECT: TWO-WAY ANALYSIS OF VARIANCE FOR COMPLETION TIME

their learning materials than no context groups in either step level. Differences within either step level were nonsignificant for all levels of context. Figure 3 illustrates these relationships and the interaction effect of context and size of step. Arrangement of the means in terms of length of time reveals the following order: (a) large-steps--superordinate context > coordinate context > no context, and (b) small-steps--coordinate context > superordinate context > no context.

Retention Test Data

Application of a two-way analysis of variance to the achievement scores for the retention test as shown in Table 7 indicated still another significant main effect for the size of step variable ($F = 10.20$, $df = 1$, $p < .005$). Figure 4 demonstrates this interaction effect and the relationship of the mean retention scores for the treatment groups.

Data for the Newman-Keuls test (Table 8) did not support the third, fourth and fifth research hypotheses. For example, the third hypothesis (that the retention scores of the superordinate and coordinate context groups would be significantly higher than those of the no context groups at either size of step level) was not supported even though the mean score of the superordinate context and small step-size group was higher than the coordinate

TABLE 7

OUTCOME OF THE TWO-WAY ANALYSIS OF VARIANCE: RETENTION SCORES

Source	df	SS	MS	F
Context (A)	2	8.54	4.27	-
Size of Step (B)	1	68.32	68.32	10.20*
A X B	2	78.64	39.32	5.87**
Within	72	482.46	6.70	

*$p < .0005$
**$p < .005$

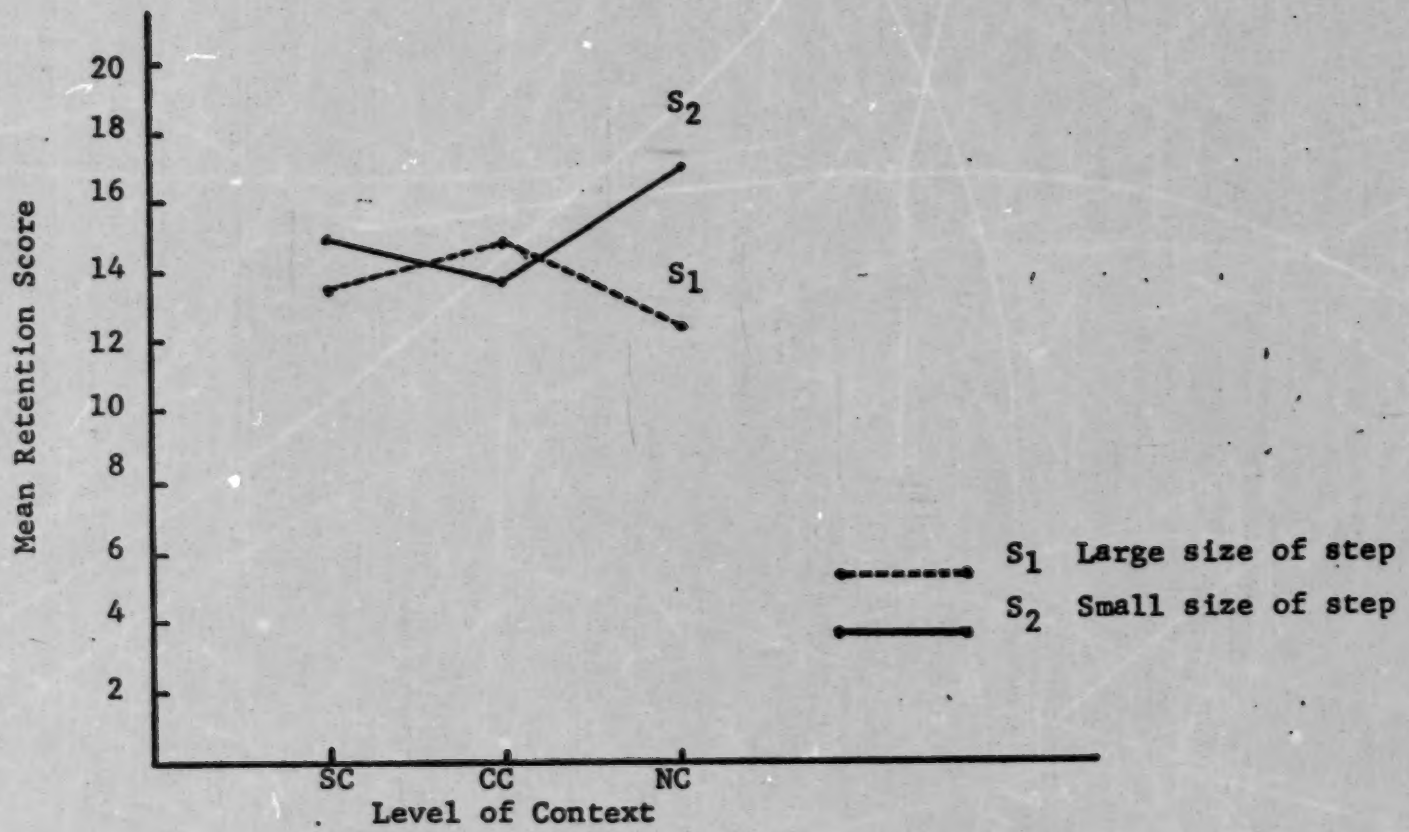


FIGURE 4

INTERACTION EFFECT: TWO-WAY ANALYSIS OF VARIANCE FOR RETENTION SCORES

TABLE 8

OUTCOME OF THE NEWMAN-KEULS TEST:
RETENTION SCORES

	$\bar{X}_3$	$\bar{X}_1$	$\bar{X}_5$	$\bar{X}_2$	$\bar{X}_4$	$\bar{X}_6$
$\bar{X}_3$ = 12.23	-	1.23	1.30	2.39	2.62	4.54**
$\bar{X}_1$ = 13.46		-	0.07	1.16	1.39	3.31*
$\bar{X}_5$ = 13.53			-	1.09	1.32	3.24*
$\bar{X}_2$ = 14.62				-	0.23	2.15
$\bar{X}_4$ = 14.85					-	1.92
$\bar{X}_6$ = 16.77						-

*$p < .05$

$$W_r = q_r\sqrt{MS_{error}/n}$$

$W_2 = 2.82 \sqrt{6.70/13} = 1.93$

$W_3 = 3.39 \sqrt{6.70/13} = 2.44$

$W_4 = 3.73 \sqrt{6.70/13} = 2.69$

$W_5 = 3.97 \sqrt{6.70/13} = 2.86$

$W_6 = 4.15 \sqrt{6.70/13} = 2.99$

**$p < .01$

$W_2 = 3.75 \sqrt{6.70/13} = 2.70$

$W_3 = 4.26 \sqrt{6.70/13} = 3.07$

$W_4 = 4.57 \sqrt{6.70/13} = 3.29$

$W_5 = 4.80 \sqrt{6.70/13} = 3.46$

$W_6 = 4.97 \sqrt{6.70/13} = 3.58$

one at the same level of size of step (cf. Table 9). In the large-step level (line S_1, Figure 4), superordinate and coordinate context scores were higher than no context ones, but these differences were nonsignificant. The mean retention score of the no context and small step-size group was significantly superior to that of the no context and large step-size group ($p < .01$). The performance of the control group, shown in line S_2 (Figure 4), was significant ($p < .01$) in relation to the retention scores of the no context and large-step group and the coordinate context and small-step group. There were no significant differences to support the fourth hypothesis that the retention scores of the superordinate context groups would be higher than those of the coordinate context group at either size of step level. However, the means for small size of step in Table 7 reveal that the superordinate context group retained more than the coordinate context group. An opposite relationship appears in the large-step level. The fifth hypothesis (that the retention scores of the superordinate context and large-step group would be significantly higher than those of the control group) was clearly not supported. The performance of the control group was significantly better at the .05 level. In general, the means for the recognition scores were arranged thus: no context and

TABLE 9

MEANS FOR RETENTION SCORES

	Context		
	SC	CC	NC
Size of Step:			
Large	13.46	14.62	12.23
Small	14.85	13.53	16.77

Note: The following abbreviations represent levels of context:

SC = Superordinate context
CC = Coordinate context
NC = No context

small step-size > superordinate context and small step-size > coordinate context and large step-size > coordinate context and small step-size > superordinate context and large step-size > no context and large step-size.

Table 10 shows the percentage of meaningful material remembered for the six groups in the experiment. This percentage is based upon the following types of questions: (a) recognition of the paraphrased sentences which represented the five main facts to be remembered, (b) recall of the facts (correct completion of the paraphrased sentences), and (c) recognition of examples of the main facts to be remembered. With respect to all treatment groups, the control group had the highest scores in each of these categories. The superordinate context and small size of step group had the second highest scores for recognition and recall of facts, while the coordinate context and large-step group had the second highest score for recognition of examples. The scores of the superordinate context and small size of step group were more closely similar than those of any other single treatment group for all three types of questions.

TABLE 10

MEAN PERCENTAGE OF RECOGNITION AND RECALL SCORES FOR THE SIX GROUPS OF THE EXPERIMENT

Type of Question	Groups					
	SCL	SCS	CCL	CCS	NCL	NCS
Recognition of fact	52	74	60	65	51	83
Recall of fact	65	74	65	66	55	91
Recognition of example	72	73	76	70	69	81

Note: The following abbreviations represent treatment groups:

SCL = superordinate context and large size of step
SCS = superordinate context and small size of step
CCL = coordinate context and large size of step
CCS = coordinate context and small size of step
NCL = no context and large size of step
NCS = no context and small size of step

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

> The emergence of new meanings in the learner reflects the completion of a meaningful learning process.
>
> David P. Ausubel (1968)

Summary

The following significant relationships appeared in the analysis of the data for acquisition errors, completion time, and achievement as measured by retention scores:

1. The size of step variable was a significant factor for acquisition, completion time, and retention.
2. The interaction of the context and size of step variables was significant for completion time and retention.
3. All small-step treatment groups took significantly longer than large-step groups to complete their linear instructional programs.
4. The control group, which had no context and small steps, performed significantly better

than (a) superordinate context and large steps, (b) no context and large steps, and (c) coordinate context and small steps. Table 11 offers a summary of these results.

Size of step instead of context was a significant factor for meaningful learning and retention in terms of acquisition errors, completion time, and achievement as measured by retention scores. The experimental subjects required significantly more time to complete the small-step instructional sequences than the large-step ones. The superordinate and coordinate context groups at both levels of step-size required more than no context groups. The coordinate context group took longer than the superordinate context group at the small size of step level. The superordinate context group required more time than the coordinate context group at the large-step level.

The control group retained significantly more meaningful information after a two-day period than the superordinate and coordinate context and large size of step groups and the coordinate context and small size of step group. However, the superordinate context and small step-size group had a higher mean retention score than the corresponding context group, even though its score was not as high as that of the control group for that size of step level. In the large-step condition, the coordinate context group retained more than the superordinate and no

TABLE 11

SUMMARY OF SIGNIFICANCE AND GROUPS FAVORED

Data	Context	Size of Step	Interaction	Groups
Acquisition Errors	—	F = 7.29 sig. (.01)	—	—
Completion Time	—	F = 59.37 sig. (.0005)	F = 12.27 sig. (.0005)	SCS, CCS and NCS required significantly more time than SCL, CCL and NCL ($p < .01$)
Retention Scores	—	F = 10.20 sig. (.0005)	F = 5.87 sig. (.005)	Control group (NCS) performed significantly better than SCL and NCL ($p < .05$) and CCS ($p < .01$)

Note: The following abbreviations represent treatment groups:

SCL = superordinate context and large size of step
SCS = superordinate context and small size of step
CCL = coordinate context and large size of step
CCS = coordinate context and small size of step
NCL = no context and large size of step
NCS = no context and small size of step

context groups. This same group also had a higher mean retention score than the coordinate context and small size of step group.

Conclusions

The results of this study do not support the application of context statements in the form of advance organizers to a linear instructional program. In terms of achievement as represented by mean retention scores, a small-step program without advance organizers is significantly superior to small-step treatments with superordinate and coordinate context. A mean of 85% in a range of 58-85% for mean retention scores of all treatment groups is indicative of the importance of a small-step program which does not have organizers. Such a program also requires less time to complete than other programs having organizers and small size of step. Thus the present study does not uphold Ausubel's (1968) contention that a small step-size approach to programing substantive material is "empirically unsupportable."

The data for acquisition errors indicate that superordinate context is better for learning than coordinate context or no context at the small-step level. This relationship does not appear at the large-step level, for the mean number of acquisition errors is slightly higher than the other means for coordinate context and no

context. However, large-step differences are minimal in this case since the largest mean is so small that it constitutes less than one-third of an error per pupil.

The significant interaction effect of context and size of step ($F = 12.27$, $df = 2$, $p < .0005$) for completion time occurred because the superordinate and coordinate levels of context behaved differently under different levels of size of step. Coordinate context took longer than superordinate context at the small size of step level, while superordinate context required more time than coordinate context at the large size of step level. The fact that the superordinate context condition took less time than the coordinate one at the small-step level suggests that superordinate context is more effective than coordinate context in mobilizing relevant anchoring ideas in cognitive structures when more propositional material is present. This interpretation follows Ausubel's (1968) theoretical position that efforts to mobilize anchoring ideas within a preexisting cognitive structure improve the retention of meaningful facts and Gagné's (1969) finding that a superordinate context condition has a significantly greater amount of recall than a coordinate one. At the small-step level, the use of topic sentences as organizers brings about a significantly greater amount of recall than the use of related sentences. However, the remembering of context material as opposed to no context is

accompanied by lower retention for both levels of size of step.

Line S_1 (Figure 3) indicates that superordinate context in the large-step level does not lead to faster completion than coordinate context. Line S_2 for the small-step level follows a more predictable pattern, for coordinate context requires more time to be understood since it does not readily mobilize appropriate anchoring concepts within cognitive structures. Retention scores are correspondingly higher for superordinate context over coordinate context at the small-step level (cf. line S_2, Figure 4), but the downward turn of line S_1 at the superordinate context interval in Figure 4 suggests that superordinate context is not as effective as coordinate context in facilitating the subsumption of potentially meaningful information when smaller quantities of related information are present.

A less important finding is that the amount of recall of five facts to be remembered ranged from 55% under the least favorable condition (coordinate context and large step-size) to 91% under the most favorable condition (no context and small step-size) after 2 days. Gagné (1969) found that a similar recall ranged from 57 to 77% for coordinate context and no context conditions. In an earlier study, Gagné and Wiegand (1968) considered minimal familiarity in the retention of facts represented by the

relation of a "thing" component (nonsense name) and an "action" component (drawing a figure on paper) learned in one trial. After a 3-day period, a retention of 20% was determined. The present investigation and Gagné's (1969) study contained highly familiar thing concepts (mother, child, tail, tree, etc.). Thus a higher degree of familiarity had some effect upon greater retention in these studies.

Analysis of the data in the present study suggests the occurrence of retroactive interference in the superordinate and coordinate context learning conditions. This effect is reflected in the significant interaction of context and size of step variables ($F = 5.86$, $df = 2$, $p < .005$) in terms of retention scores and by other relationships in the data for acquisition errors, completion time, and achievement as measured by the retention test. Slightly larger mean acquisition errors for the superordinate and coordinate context groups in the large-step level point in this direction, but a larger error mean for the coordinate context and small-step group in relation to the control group reflects the effect of interference to a greater degree. The fact that the experimental subjects performed less well than might be expected in terms of acquisition at the small-step level implies that interference took place in the learning of meaningful material. At this step level, neither superordinate or

coordinate context groups performed as well as the control group. This is an important finding, because Gagné (1969) had previously located interference only in the retrieval stage of remembering. Gagné (1969) attributed the superiority of no context to a reduction in interference since facts to be remembered could not be inhibited by context information in organizers.

The data for completion time also suggest an interference effect, because the mean completion time for the small-step context groups was approximately 3 to 5 minutes longer than the mean for the control group. The means of the large-step context groups ranged from 45 seconds to 2 minutes longer than the mean for the no context group which had large-steps. Obviously, the superordinate and coordinate context groups needed more time to read the context statements, but reading each context statement containing a single simple sentence does not account for all of the extra time required in the superordinate and coordinate context conditions to complete the instructional materials.

Interference was not measurable in the large-step learning conditions. The coordinate context group had a higher mean retention score than the no context group at the large-step level. Both superordinate and coordinate context groups had higher mean retention scores than no context for this level. If interference had taken place

in these conditions, retention scores for the large-step context groups would probably have been lower than those for no context.

This study found that the sequencing of additional context statements in the form of advance organizers did not improve a linear instructional program. A more important observation for further research may be the fact that the organization of facts into topics with context sentences does facilitate the retention of meaningful facts in the small size of step condition despite the presence of interference. Another implication of this study is that advance organizers may function less effectively in mobilizing anchoring ideas within a pre-existing cognitive structure when smaller amounts of potentially meaningful information are involved in the learning material as they were in the large-step learning condition.

Recommendations

The effects of context and size of step should be investigated under different conditions employing other definitions and levels of size of step. Context effects should also be studied when advance organizers are hierarchically ordered in terms of their own generality and inclusiveness and subsequently sequenced into an instructional program. The possible existence of a cue effect

(when the introductory remark, "This sentence tells what the next few are all about," is used in the superordinate learning condition) should be considered. The present study also raises the possibility that certain limits may exist for the number of ideas that context statements can effectively organize and relate to anchoring ideas in cognitive structure. This possibility should be investigated. An examination of all these areas of concern under linear and branching conditions might lead to a better understanding of the application of Ausubel's theory of meaningful learning to programed instruction and the appropriate use of context and size of step.

A P P E N D I C E S

APPENDIX A

LINEAR INSTRUCTIONAL PROGRAM

The format of the actual programed lesson on howler monkeys has been abridged so that it may be represented here. In the original learning material, correct responses appeared consecutively on subsequent pages. Here they are placed beneath each completion blank for ease of reading. Superordinate or coordinate context sentences were sequenced before meaningful facts to be remembered for certain treatment levels.

Howler Monkeys

Frame

1 Young howler monkeys wrestle and chase eath other in play. One howler monkey may grab another and tumble him. Howlers run when they ch____ (chase) each other.

2 Young howler monkeys may sometimes make each other fall when they wrestle. They almost seem to play tag when they ch____ (chase) each other.

3 Young howler monkeys may push each other off balance when they wr_____ (wrestle).

4 Young howler monkeys wrestle and _____ (chase) each other in play.

5 Young howler monkeys may play a little roughly when they wrestle. Howlers like to run after each other. They enjoy playing games when they are young. Young howler monkeys _____ and chase each other in play.
(wrestle)

6 Young howler monkeys _____ and _____ each other in play.
(wrestle) (chase)

7 Mother howler monkeys carry their babies with them wherever they go. A mother howler usually has just one baby. This howler baby holds on to his m_____.
(mother)

8 Mother howlers carry their babies in two different ways. She can _____ her baby on her back or under her.
(carry)

9 A howler baby clings to his m_____.
(mother)

10 Mother howler monkeys c_____ their babies with them wherever they go.
(carry)

11 Mother howler monkeys carry their babies when they visit or look for food. Mother howlers carry their babies when they escape sudden danger. They carry them on their backs or under their bodies. Mother howler monkeys carry their _____ with them wherever they go.
(babies)

12 Mother howler monkeys _____ their _____ with them wherever they go.
(carry) (babies)

13 Howler monkeys roar and throw objects at animals they are afraid of. Howler leaders warn away other tribes of monkeys. Howlers sometimes throw things within their reach at animals they are _____ of.
(afraid)

14 Howler monkeys don't just howl when they are afraid of other monkeys. They _____ and throw things.
(roar)

15 When they are frightened, howlers may _____ (throw) anything that is within their reach.

16 Howler monkeys roar and throw objects at animals they are a_____ (afraid) of.

17 If a strange tribe of monkeys came near, howlers would roar and they might pick up things to throw. Howlers are very noisy when they are afraid. Their roar is much louder than a howl. Howler monkeys roar and _____ (throw) objects at animals they are afraid of.

18 Howler monkeys _____ (roar) and throw objects at animals they are _____ (afraid) of.

19 A howler monkey uses his tail as another hand. A howler monkey can grip things with his tail. A howler can eat with a hand or foot while he hangs by his t_____ (tail).

20 A howler monkey can pick up things with his tail. A howler monkey can grip things with his t_____ (tail).

21 Instead of using his hand or foot, a howler can pick up something as small as a peanut with his _____ (tail).

22 A howler monkey uses his tail as another _____ (hand).

23 A howler monkey can grasp things with the tip of his tail. The tip of his tail can bend around things. He can also hang by his tail. A howler monkey uses his tail as another _____ (hand).

24 A howler monkey uses his _____ (tail) as another _____ (hand).

25 Howler monkeys prefer to live in forests of tall trees. Howlers travel through trees. They howl and roar from _____ (trees).

26 Howlers like to live in treetops. If you were watching them, you would see them live in tree_____ (tops).

27 Howlers like to l____ (live) in trees.

28 Howler monkeys prefer to live in forests of tall _____ (trees).

29 Howler monkeys make their homes in trees. Howlers can be found in treetops. The trees protect and shade them. Howler monkeys prefer to live in forests of tall _____ (trees).

30 Howler monkeys prefer to _____ (live) in forests of tall _____ (trees).

APPENDIX B

SUPERORDINATE SENTENCES

In this study, superordinate sentences--which were topic sentences--were more inclusive and general than the following: (a) coordinate or related sentences in the coordinate learning condition; (b) meaningful facts to be remembered, which appeared in the sequences as RU's (rules); (c) subsequent examples of these facts, which were called EG's.

Topic sentences were inserted at the beginning of each frame sequence in the superordinate learning condition, and they were prefaced by the remark, "This sentence tells what the next few are all about." In terms of their relationship to particular sequences, these superordinate sentences were:

Frames 1-6:	Young howlers have many forms of play.
Frames 7-12:	Howler mothers take very good care of their children.
Frames 13-18:	Howlers are usually peaceful, but they do try to frighten their enemies.

Frames 19-24: A tail is very important to a howler monkey.

Frames 25-30: Groups of howlers live in treetops deep in the forest.

APPENDIX C

COORDINATE SENTENCES

Coordinate sentences were placed at the beginning of each frame sequence in the coordinate learning condition. Each one conveyed a particular correlative fact related to the meaningful fact to be remembered in that sequence. These sentences were less inclusive and general than the topic sentences in the superordinate learning condition, and they were not preceded by any remark. They were the following:

Frames 1-6:	Young howler monkeys play when the sun gets hot.
Frames 7-12:	Howler mothers do not grow tired of their babies.
Frames 13-18:	Howler monkeys sometimes roar all day and night.
Frames 19-24:	Howler monkeys have a pattern of ridges like "fingerprints" under the tips of their tails.
Frames 25-30:	Howler monkeys sleep in outer tree branches.

APPENDIX D

RETENTION TEST AND INSTRUCTIONS

The retention test for recognition and recall was administered on the second day following instruction. Correct answers were randomly ordered among the possible responses to its twenty questions. A reliability coefficient ($r = +.80$) was determined for this instrument in a sample of 25 fifth grade pupils using the test-retest method with a one-week interval.

Instructions for this retention test directed subjects to do the following tasks: (a) choose the fact that they had previously learned; (b) select the right word or words to complete that fact's response blank or blanks; (c) determine the correctness of paraphrased examples based upon the original learning material. These instructions were the following:

There are 20 questions. The first ten are multiple-choice. Circle the letter in front of the best answer.
Example:

1. Which sentence best tells what you have learned?

(A) Traffic lights are red, orange, and _____.
(B) Traffic lights are red, green, and _____.
(C) Traffic lights are blue, green, and _____.
(D) Traffic lights are red, amber, and _____.

2. Which word should be in the blank in the correct answer to Question #1?

(A) green
(B) black
(C) purple
(D) yellow

The next ten questions are true-false. Circle the letter in front of the best answer.

Example:

3. Traffic lights help you in crossing streets.

(A) True
(B) False

Do NOT turn the page until you are told to do so. Remember to circle the letter in front of the best answer. Do all 20 questions. Then turn your booklet over.

The retention test appeared as a five-page booklet with four questions on each page. These questions were:

1. Which sentence best tells what you have learned?

(A) A howler monkey will _____ and _____ its baby when it is lost.
(B) A howler monkey will _____ and _____ another howler when they fight.
(C) A howler monkey will _____ and _____ another howler when they hunt.
(D) A howler monkey will _____ and _____ another howler when they play.

2. Which words should be in the blanks in the correct answer to Question #1?

(A) howl and roar at
(B) roar and throw things at
(C) wrestle and chase
(D) chase and carry

3. Which sentence best tells what you have learned?

(A) Howler babies are always _____ by their sisters.
(B) Howler babies are always _____ by their mothers.
(C) Howler babies are always _____ by their brothers.
(D) Howler babies are always _____ by their fathers.

4. Which word(s) should be in the blank in the correct answer to Question #3?

(A) carried
(B) wrestled
(C) howled at
(D) chased

5. Which sentence best tells what you have learned?

(A) Howler monkeys _____ and _____ when they are happy to see other monkeys.
(B) Howler monkeys _____ and _____ when they are sad.
(C) Howler monkeys _____ and _____ when they are afraid of other monkeys.
(D) Howler monkeys _____ and _____ when they are hungry.

6. Which words should be in the blanks in the correct answer to Question #5?

(A) wrestle and chase
(B) cry and leap away
(C) howl and roar
(D) roar and throw objects

7. Which sentence tells best what you have learned?

(A) A howler monkey can use his tail like a _____.
(B) A howler monkey can use his body like a _____.
(C) A howler monkey can use his arm like a _____.
(D) A howler monkey can use his leg like a _____.

8. Which word should be in the blank in the correct answer to Question #7?

(A) mouth
(B) hand
(C) foot
(D) head

9. Which sentence best tells what you have learned?

(A) Howler monkeys prefer most of all to sleep in _____.

(B) Howler monkeys prefer most of all to howl in _____.

(C) Howler monkeys prefer most of all to live in _____.

(D) Howler monkeys prefer most of all to play in _____.

10. Which word(s) should be in the blank in the correct answer to Question #9?

(A) grass lands
(B) forests
(C) caves
(D) rocky places

11. Howler monkeys never warn others.

(A) True
(B) False

12. A howler monkey usually takes care of more than one baby at a time.

(A) True
(B) False

13. A howler monkey holds its baby in its arms whenever it goes somewhere.

(A) True
(B) False

14. A howler monkey can hang from a tree without using his hand or his foot.

(A) True
(B) False

15. Howler monkeys are often seen traveling along the ground.

(A) True
(B) False

16. Howler monkeys howl and roar.

(A) True
(B) False

17. In playing, a howler monkey may reach for another howler and pull him over.

(A) True
(B) False

18. Howler monkey leaders always welcome new tribes of monkeys.

(A) True
(B) False

19. A howler monkey cannot use his tail for picking up things.

(A) True
(B) False

20. Howler monkeys sometimes run after each other when they are young.

(A) True
(B) False

APPENDIX E

DATA ON ALL MEASURES

Student No.	Treatment Group	Acquisition Errors	Completion Time (min.)	Total Test	Recognition of Fact	Recall of Fact	Recognition of Example
# 1	CCS	1	22	18	4	5	9
# 2	NCL	0	3	14	3	3	8
# 3	SCS	0	26	13	3	2	8
# 4	SCS	0	12	17	4	4	9
# 5	CCS	2	6	13	3	3	7
# 6	NCS	0	13	14	3	4	7
# 7	SCL	0	5	16	4	3	9
# 8	CCS	0	10	14	2	3	9
# 9	SCL	0	10	16	4	5	7
#10	CCL	0	4	13	3	3	7
#11	SCL	0	12	15	3	4	8
#12	NCS	2	11	18	5	5	8
#13	SCS	0	13	15	4	4	7
#14	NCS	0	16	19	4	5	10
#15	NCL	0	2	15	3	3	9
#16	SCL	1	7	14	4	4	6
#17	NCL	0	1	13	4	4	5
#18	NCL	0	6	17	4	4	9
#19	SCS	0	17	17	4	4	9
#20	NCS	0	17	15	3	5	7
#21	SCS	1	18	16	5	4	7
#22	CCL	1	2	11	2	3	6
#23	CCS	0	12	14	3	3	8
#24	CCL	1	6	15	3	3	9
#25	SCL	0	7	14	4	3	7
#26	SCS	1	26	14	4	4	6
#27	SCS	0	4	15	3	4	8
#28	NCS	0	11	18	4	5	9
#29	CCL	0	3	9	3	3	3
#30	SCS	0	10	16	4	4	8
#31	SCL	0	3	12	2	2	8
#32	SCL	0	6	17	5	4	8
#33	CCL	0	4	17	4	3	10
#34	NCL	0	4	14	3	3	8
#35	NCL	1	1	13	3	2	8
#36	CCL	0	6	16	5	4	7
#37	NCS	1	8	18	5	5	8
#38	NCL	0	4	12	1	3	8

DATA ON ALL MEASURES--(continued)

Student No.	Treatment Group	Acquisition Errors	Completion Time (min.)	Total Test	Recognition of Fact	Recall of Fact	Recognition of Example
#39	CCS	0	24	10	2	2	6
#40	NCS	0	6	17	5	5	7
#41	CCS	0	15	12	5	3	4
#42	NCS	1	24	19	5	5	9
#43	NCL	0	2	12	2	2	8
#44	SCL	0	6	12	3	3	6
#45	CCS	0	8	10	4	1	5
#46	CCL	0	5	16	3	4	9
#47	SCS	0	11	7	1	2	4
#48	SCL	0	6	13	2	3	8
#49	CCS	0	11	18	5	5	8
#50	CCS	0	22	13	2	3	8
#51	CCL	0	4	17	4	4	9
#52	SCL	1	2	12	1	4	7
#53	NCL	0	5	12	2	3	7
#54	CCL	0	5	14	2	4	8
#55	CCL	0	3	14	2	3	9
#56	NCL	0	2	6	0	1	5
#57	NCL	0	5	12	3	3	6
#58	SCS	0	15	18	4	4	10
#59	NCL	0	5	9	2	3	4
#60	NCS	1	13	17	4	4	9
#61	CCS	1	17	13	3	4	6
#62	NCS	0	12	11	2	2	7
#63	SCS	3	20	18	5	5	8
#64	SCL	2	8	8	2	2	4
#65	SCS	0	20	16	4	4	8
#66	NCS	5	13	17	5	5	7
#67	CCS	0	15	11	2	3	6
#68	NCS	2	16	17	5	5	7
#69	SCL	0	7	12	2	2	8
#70	SCS	4	25	11	3	3	5
#71	CCL	0	7	13	2	2	9
#72	NCS	4	19	18	4	4	10
#73	NCL	0	3	10	3	2	5
#74	CCS	7	40	16	4	4	8
#75	CCL	1	3	12	3	3	6
#76	CCL	0	1	13	3	3	7
#77	SCL	0	5	14	4	3	7
#78	CCS	10	39	14	3	4	7

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